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“Cooperation limitations under a one-time threat of expulsion and
punishment”

by

Pam Schmitt

U. S. Naval Academy

&

Aaron Lowen

Grand Valley State University

Cooperation limitations under a one-time threat of expulsion and punishment

Aaron Lowen, Department of Economics, Grand Valley State University, 401 W Fulton St, Grand Rapids, MI 49504, Email:lowena@gvsu.edu, Phone: 616-331-7441, Fax: 616-331-7445

Pamela Schmitt*, Department of Economics, U.S. Naval Academy, 589 McNair Rd, Annapolis, MD 21402, Email:pschmitt@usna.edu, Phone: 410-293-6888, Fax: 410-293-6899

Abstract:

We examine the role one-time threats of expulsion and punishment have on voluntary contributions in a public goods game. This paper extends the work of Cinyabuguma, Page, and Putterman (2005), who find that the threat of expulsion in every period raises contributions to near Pareto Optimal levels. In our experiments, participants played in 15-round sessions where they were allowed to vote to remove other subjects only after round 5 and in one design also voted whether to punish the remaining subjects after round 10. We find that the additional threat of punishment not only increased the contributions of participants before the punishment vote, but also resulted in the expulsion of participants who had contributed more than in the no punishment treatment. Efficiency with expulsion is 58.07% without punishment, and 57.13% with punishment, including the cost for voting and punishment. Our findings indicate that the threat of expulsion as a sanctioning mechanism may not be helpful for public good provision unless expulsion can occur in every period, the threat of costly punishment increases contributions with little impact on efficiency, and that standards for inclusion rise when later punishment is available.

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* Corresponding author: 589 McNair Road, Department of Economics, Annapolis, MD 21402, phone (410) 293-6888, fax (410) 293-6899, email: pschmitt@usna.edu

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1. Introduction

Social dilemmas arise when the incentives faced by individual group members lead to outcomes that are suboptimal from the perspective of the group. Economic environments involving voluntary contributions to a public good have the incentive properties of a social dilemma. Laboratory public good experiments have demonstrated that individuals may cooperate significantly more than predicted by game-theoretic, Nash Equilibrium predictions, but rarely reach and sustain Pareto optimal outcomes (see Ledyard (1995)).

Previous experimental research on contributions to public goods has demonstrated the importance of fairness (Andreoni (1995)), reciprocity/conditional cooperating, (Fischbacher, Gächter, and Fehr (2001)), learning (Sonnemans, Schram, and Offerman (1999)), or a combination of the three (Cooper, Kraker, and Stockman (2002), Harbaugh and Krause (2000)). The establishment of group identity (Eckel and Grossman (2005), Solow and Kirkwood (2002), and Keser and van Winden (2000)), and creating social norms (Rege and Telle (2004) and Tyran and Feld (2002)) have also been examined. The roles of repeated interactions, group size, and communication (with and without punishment) for cooperation have also been studied (Güerker, Irlenbusch, and Rockenbach (2006), Galbiati and Vertova (2008), Isaac, Walker, and Williams (1994), and Ostrom, Walker, and Gardner (1992), Isaac and Walker (1988)).

The literature has shown that the ability of groups to establish rules for individual behavior and sanction offenders is often a critical element in improving efficiency in such situations (Ertan, Page, and Putterman (2009), Ones and Putterman (2007), Sefton, Shupp, and Walker (2006), Güerker, Irlenbusch, and Rockenbach (2006), Cinyabuguma, Page, and Putterman (2005), Page, Putterman, and Unel (2005), Egas and Riedl (2005), and Fehr and Gächter (2000)), even though sanctioning is likely to be neither automatic nor costless to the enforcer. Finally, the ability to form groups impacts efficiency. In particular, Ahn, Isaac, and Salmon (2008) find that restricting entry decreases efficiency because the cost of smaller groups mitigates the impact of increased contributions, while Ahn, Isaac, and Salmon (2009) find that

restricting entry increases efficiency only if the public good is congestible. Similarly, Page, Putterman, and Unel (2005) find that endogenous group formation increases efficiency.

This paper extends the work of Cinyabuguma, Page, and Putterman (2005) who find that the threat of expulsion in every period raises contributions to near Pareto Optimal levels (except for the last period, contributions in the expulsion treatments averaged over 90% in almost all periods, with average contributions reaching as high as 98%). In their design, and therefore in ours, it is not rational to vote a member out if subjects are payoff maximizers because it lowers the total endowment available to the group. This sanction results in costs to the enforcer through both a direct voting cost and forgone future contributions. The sanction occurs if a majority of those in the group “vote” the subject permanently out of the group. The cost to the subject voted out is a smaller endowment (5 versus 10) and exclusion from payouts from the larger group’s public good. Maier-Rigaud, Martinsson, and Staffiero (2010) implement a similar experiment to examine the role ostracism has on contributions to a public good. They also find that contribution levels increase when group members are able to vote to ostracize group members in each period.

Cinyabuguma et al. (2005), Maier-Rigaud et al. (2010), Page et al. (2005), and Ahn et al (2009) discuss the institutional framework for which this type of expulsion or regrouping is relevant. While local public goods and reformation of teams after a project is complete are relevant, frequent expulsion decisions are not. Ahn et al (2009) discusses examples of limited expulsion including a town or city de-annexing, evicting apartment co-op members, and the firing of tenured faculty at a university. While they analyze the role of restricted entry, we focus on the role of limited expulsion in mitigating free-riding.

Our primary contribution to the literature is an examination of the effect one-time threats of expulsion and punishment have on contributions to a public good. To this end, our design differs from Cinyabuguma et al. (2005) in that subjects were allowed to vote to remove other subjects only between rounds 5 and 6 (the “expulsion only” treatment), and in one treatment subjects also voted whether to punish the remaining individuals between rounds 10 and 11 (the “with punishment” treatment). The data

show that the additional threat of punishment not only increased the contributions of participants before the punishment vote, but also resulted in the expulsion of participants who had contributed more than in the expulsion only treatment. While lower than the nearly full efficiency levels found by Cinyabuguma et al. (2005) when the threat of expulsion was available in every period, we find efficiency with expulsion is approximately the same in the periods without punishment (58.07%) as with punishment (57.13%) when including the cost for voting and punishment. (Both are much higher than in their treatment with no expulsion in any period). Thus, while adding the ability to punish to a threat of expulsion changes contribution and voting behavior, it has little impact on efficiency. Finally, we find that the level of contributions necessary to avoid expulsion is higher when later punishment is available.

The paper proceeds as follows. Section 2 describes the experiment and subjects. Section 3 presents results followed by discussion and concluding remarks in Section 4.

2. The Experiment

In a public goods experiment, subjects receive an endowment each period which they can distribute between a private account and a group account. Money placed in the private account provides earnings for the subject only. Money placed in the group account provides earnings for all subjects in the group, but the amount earned by the individual is less than they could earn in the private account.¹ While the Pareto Optimal outcome is for all subjects to place all their money in the group account, the Nash Equilibrium is for all subjects to place all their money in the private account. As with any public good, participants have an incentive to free-ride.

¹ This rate varies throughout the literature, but we use a marginal per capita return (MPCR) of \$0.20 for all 16 members of the group, therefore creating an efficiency factor of \$3.20 if all members remain in the group. As noted by Cinyabuguma et al. (2005), choosing a MPCR = 0.20 yielded similar results to Isaac and Walker's (1988) 10 player design with a MCPR = 0.30.

As in Cinyabuguma et al. (2005), our subjects played a repeated public good game in which they started in the Green Group (receiving an endowment of E\$10² each period) and could be voted out and placed in the Blue Group (receiving an endowment of E\$5 each period). The Green Group was initially composed of 16 subjects who receive an endowment of \$10 experimental dollars (hereafter, E\$10) for each of 15 periods. In a given period, a subject i 's earnings in experimental dollars is given by:

$$(10 - C_i) + (0.2) * \sum C_j \quad (1)$$

where C_i is the amount that i contributed to the group account, and $\sum C_j$ is the sum of contributions to the group account by all members, i included. Subjects are informed of their total earnings after every round.

This paper extends Cinyabuguma et al. (2005) by only allowing voting to expel once (between periods 5 and 6), and allowing an additional punishment for those not voted out of the Green group (between periods 10 and 11). These design changes allow us to examine if the threat needs to be available every period to achieve the Pareto Optimal outcome, or if it can be sustained once it is achieved through the threat of exclusion or punishment. Subjects received complete information regarding the treatment. That is, before subjects made any decision, they were instructed that they would be able to vote to expel members of the group (or could be expelled) after period 5 and, in the punishment treatment, they were instructed that they would be able to punish remaining members of the group (or could be punished) after period 10.

After round five, subjects receive information on the others' allocations³ to the group account. This information includes the amounts each participant allocated to the group account, their earnings, and the average amount each allocated to the group account in each of the first 5 rounds. Next to the information for each subject is a box that can be checked to remove the individual in question from the Green Group. If a majority of members from the Green Group (eight or more) vote to expel a group

² Experimental dollars were worth \$0.05 each, paid in cash at the end of the session. Earnings ranged from \$8.13 to \$18.7, averaging about \$13.82 for a 60-minute session.

³ All members of the group are identified by letters in order to maintain confidentiality.

member, that individual is moved to the Blue Group for the remaining 10 rounds. In each subsequent round, Blue Group members face the same allocation decision as those in the Green Group, but have E\$5 to allocate rather than E\$10. That is, those in the Blue Group face the same MPCR as those in the Green Group, but have the disadvantage of having a lower endowment and fewer group members.

When a subject is moved to the Blue Group from the Green Group, each member that voted to remove that subject is charged E\$0.25. This charge only occurs if the group member under consideration is actually removed from the Green Group. After the voting is complete, all group members see the results of the voting on their respective screens. Since members view the number of votes cast against them, the number of votes signals social norms which could impact subjects in the punishment design. Subjects were advised that voting a member out lowers earnings potential to both the Green group and the Blue group for each remaining period.

In addition to the expulsion only treatment, we examine a one-time expulsion, one-time punishment treatment. This experiment replicates the treatment discussed above but also includes a punishment vote after round 10. Subjects still in the Green Group after round 10 get information on others' allocations to the group account. Similar to the voting process after round 5, Green Group members have the opportunity to vote to punish other members of their group. Paralleling the expulsion vote, if half or more of the current members of the Green Group vote to punish a particular person, that person is charged E\$40.⁴ As in the expulsion vote, those successfully voting to punish a group member are each charged E\$0.25. Regardless of punishment, subjects remain in the Green Group and could only be expelled after period 5. We did not conduct baseline games or replicate Cinyabuguma et al's expulsion treatments; we ran two different treatments and compare our results to theirs.

Data was collected over a one-month period in 2009 using college students primarily recruited from Principles of Economics classes (part of the General Education program) and through posted

⁴ This amount is equal to the benefit a participant would receive from shifting E\$10 from the group account to their personal account for five rounds.

campus announcements at Grand Valley State University. Each session ran about sixty minutes, with sixteen participants in each for a total of 96 subjects. Three sessions of each treatment were conducted and each subject participated no more than once. Experiments were conducted using Z-tree (Fischbacher (2007)).

3. Results

Average participant contributions, earnings, and efficiency are summarized in Table 1 with details of the contributions given in Figure 1. In their no-expulsion baseline treatment, Cinyabuguma et al. (2005) found that average contributions were about 67% of endowment, dropping to 31% by period 3 and to 8% in the last period. In our expulsion only treatment, subjects that would remain in the Green Group contributed an average of 75% of endowment in period 1 and 67% of endowment in the five periods before the expulsion vote. Those who would be voted into the Blue Group contributed an average of 19% of endowment before the expulsion vote. In the five rounds that followed the expulsion vote the members of the Green Group contributed an average of 54% of endowment, which fell to 33% of endowment in rounds 11-15. Average contribution for the Green Group was 25% of endowment in round 15. In contrast, when Cinyabuguma et al. introduced expulsion in every period, average contributions were at least 83% in the first round and then rose and stayed over 90% until round 14 or 15, where it dropped to between 8% and 33%. Thus, while one-time expulsion without punishment generated higher average contributions than no voting and lower average contributions than voting every round (as expected), contributions remained substantially above their baseline even after the one-time vote.

When comparing voting behavior, Cinyabuguma et al.'s subjects expelled between 1 and 4 participants in most sessions, while we had on average 2 expelled in the expulsion only treatment (who contributed an average of 19% of endowment) and 3.5 expelled in the punishment treatment (who contributed an average of 38% of endowment). Figure 2 shows the number of votes to expel a participant in our treatments by the contribution level prior to the vote. The graph shows a clear distinction between

treatments both in the level of contributions and the contribution levels sufficient to be expelled. As in Cinyabuguma et al., the number of votes to expel decreased with higher contributions. Further, within each session, every participant expelled had contributed less than every participant not expelled.⁵

In our treatment with punishment, subjects that remained in the Green Group started with an average contribution of 81% of endowment and increased to 85% of endowment over the five periods before the expulsion vote (compared to 75% and 67% in the expulsion only treatment). Those who would be voted into the Blue Group contributed an average of 38% of endowment before the expulsion vote compared to 19% in the expulsion only treatment. In the five rounds following the expulsion vote and before the punishment vote, the average contribution for those in the Green Group fell from 85% to 78% of endowment (in the expulsion only treatment contributions started lower and fell further, from 67% to 54% of endowment). In the post-punishment phase the average contribution in the Green Group fell to 26% of endowment, lower than the average contributions of 33% of endowment in the expulsion only treatment. The average Green contribution in the punishment treatment was 12% of endowment in round 15, also lower than in the expulsion only treatment (26% of endowment).

Among the subjects that were not voted out of the Green Group in the punishment treatment, eight (21.6%) were punished. Those that were not punished contributed an average of 84% of endowment during periods 6-10, while those that were punished contributed an average of 54% of endowment. Figure 2 shows the number of votes to punish a participant in our treatments by the contribution level between the votes to expel and punish. After the punishment phase those that were not punished contributed an average of 27% of endowment, while those that were punished contributed an average of 24% of endowment. Thus, those who were punished did not retaliate by substantially lowering contributions relative to those who were not punished.

⁵ In the expulsion-only treatment, 115 votes were cast, of which 85 were against players who had contributed less than the voter. In the treatment with expulsion and punishment 158 votes were cast to expel, of which 122 votes were cast against players who had contributed less than the voter.

A final way to compare our two treatments is by the overall level of earnings, also provided in Table 1. In the phase before the expulsion vote the average level of earning across all participants was higher in the punishment treatment than in the expulsion only treatment. While the level of contribution was much higher in the punishment treatment, the average earning was lower in the second phase due to the costs of punishment. Despite the high cost of punishment, the average earning was still higher in the punishment phase through period 10. Thus, the peculiar nature of the contributions in the final phase (periods 11-15) has a significant contribution. That is, it changes the overall average per-round earning in the two treatments is approximately equal (E\$18.58 versus E\$18.28) which yields approximately the same level of efficiency across the treatments (58.07% without punishment and 57.13% with punishment, including the cost for voting and punishment). As can be seen in Table 1, players in the Green Group also had similar efficiency levels across the treatment (61.03% without punishment and 61.64% with punishment, including the cost for voting and punishment).

While not a primary hypothesis of this paper, we note that in the punishment treatment Greens who would be punished averaged a cumulative payoff of E\$234.81 in the round before punishment compared to E\$210.11 for those who would not be punished. When comparing final cumulative payoffs, those who were punished averaged E\$217.36 while those who were not punished averaged E\$230.23. For comparison, the players in the expulsion-only treatment averaged E\$193.15 and E\$292.94, respectively.

4. Conclusions

Following the design of Cinyabuguma, et al. (2005) (and similar to that of Maier-Rigaud et al., (2010)), we implement a public goods experiment where participants had either a one-time vote to expel other group members or a one-time vote to expel along with a one-time vote to punish remaining Green Group members. We do this to mimic an environment in which opportunities to expel or penalize a free-riding group member are infrequent.

Our first significant result is that a one-time threat of expulsion as a sanctioning mechanism reduces free-riding relative to no expulsion, but may not be helpful for public good provision unless expulsion can occur in every period. The data confirm that participants contribute more in the one-time expulsion vote treatment than in Cinyabuguma, et al.'s baseline of no expulsion. Adding a punishment vote further increases contributions, but not to as high a level as if there was a vote to expel participants every round. More interesting is the result that the average contribution in the treatment with a punishment vote drops below that in the expulsion only vote treatment. Further, the average contributions by those punished and those not punished were the same in the last five rounds of play.

Our second significant result is that the threat of costly punishment increases contributions with little impact on efficiency. This occurs through two channels. First, the presence of a punishment vote increases average contributions, but also increases the standard by which participants were judged when voting to expel from the Green Group. This resulted in more participants being voted into the Blue Group including more moderately-contributing participants being expelled. Second, the costly punishment was used with sufficient frequency to negate the social gains from the higher contribution levels such that the overall average earning is the same between the treatments.

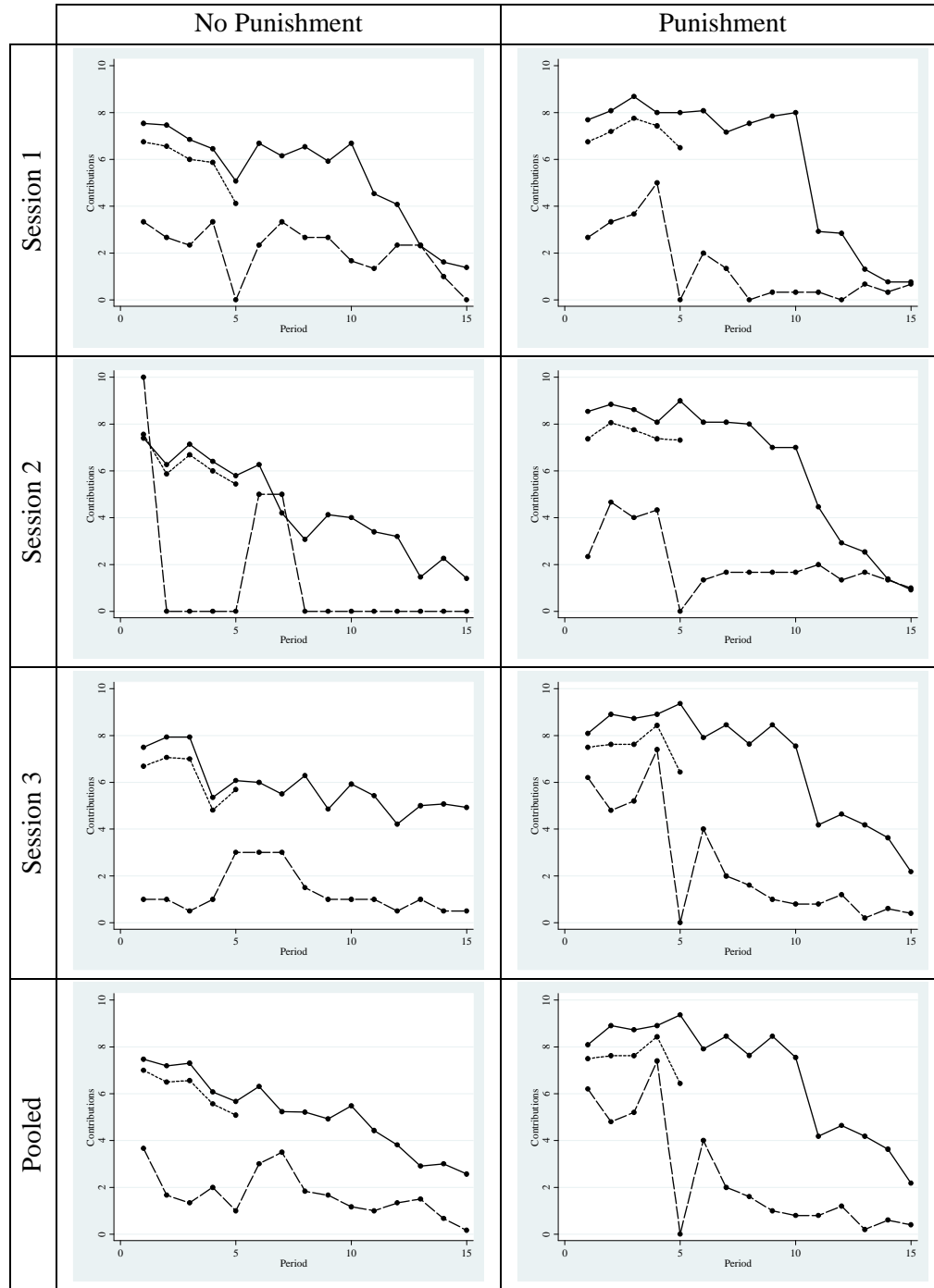
It is also interesting to note that, in this design, potential free-riders (possible expellees) may find that they can exploit the group's incentive to keep the group large. That is, expelling anyone with positive historical contributions may make the group worse off since that person is not replaced. Further research is needed to determine whether behavior changes relative to our design if members of the group know other players are available to join the group if a current group member is expelled.

Table 1: Summary Statistics⁶

| | No Punishment Treatment | | Punishment Treatment | |
|-------------------------------------|-------------------------|-------------------|----------------------|-------------------|
| | Greens | Blues | Greens | Blues |
| Number of Participants | 42 | 6 | 37 | 11 |
| Average Contribution, Periods 1-5 | 6.74 | 1.93 | 8.49 | 3.78 |
| Average Contribution, Periods 6-10 | 5.43 | 2.23 | 7.77 | 1.51 |
| Average Contribution, Periods 11-15 | 3.34 | 0.93 | 2.58 | 0.80 |
| Average Earning, Periods 1-15 | 19.53 (61.03%) | 11.95 (37.35%) | 19.73 (61.64%) | 13.42 (13.42%) |
| Average Earning, Periods 1-15 | 18.58 (58.07%) | | 18.28 (57.13%) | |
| Average Earning, Periods 1-5 | 23.45 (73.28%) | | 26.95 (84.22%) | |
| Average Earning, Periods 6-10 | 17.71 (55.35%) | | 16.24 (50.74%) | |
| Average Earning, Periods 11-15 | 14.59 (45.58%) | | 11.65 (36.40%) | |
| | | | | |

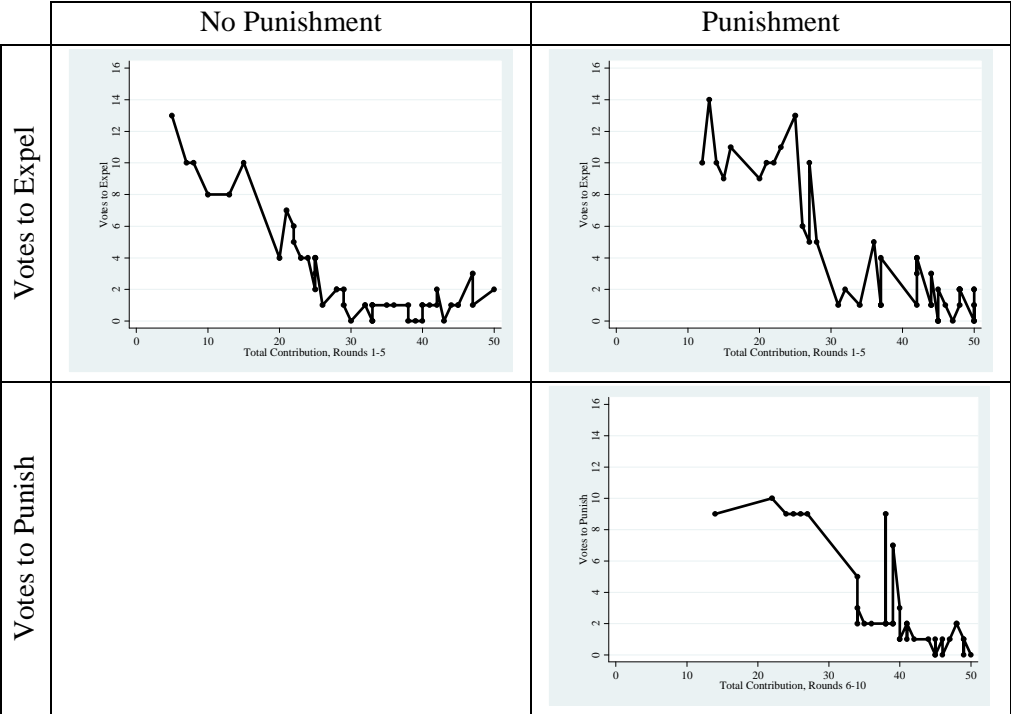
⁶ All subjects were in the Green Group in rounds one through five. Exclusion status compares those who would eventually be voted into the Blue Group to those who would not be voted out of the Green Group. Average earning indicates the average earnings in E\$ for each participant per round (both Blue and Green), and the efficiency (percent average payoff of the Pareto Optimal payoff of E\$32) is provided below in parentheses.

Figure 1: Mean Contribution by Period and Exclusion Status⁷



⁷ All subjects were in the Green Group in rounds one through five. The solid line displays the average contribution of subjects who remained in the Green Group for all rounds. The line composed of long dashes displays the average contribution of subjects who would eventually be voted into the Blue Group. The line composed of short dashes shows the contribution for all sixteen subjects for rounds one through five.

Figure 2: Votes to Expel or Punish, by Contribution Level and Treatment (Sessions Pooled)



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